Using Cluster Analysis of Rainfall in Ghana to Create a Drought Trigger for Index Insurance Affected by Climate Change

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Objective:

- Apply cluster analysis to identify payout threshold for drought
- Demonstrate associations between index and crop yield through associative modeling.

- **Purpose:**

- Develop index insurance

Need for Protecting Farmers From Drought

- Drought can destroy crops
- Climate change is making flooding and droughts more frequent
- Agriculture supports majority of the global poor
- Farmers have difficulty getting loans without insurance

How Do We Get There?

Index Insurance

- Payout occurs when pre-specified trigger is activated
- Reduces admin costs.

Data:

1. Crop (Maize) yield data were obtained from the Ministry of Food & Agriculture in Ghana.
2. Rainfall were obtained from agrometeorological stations in districts

3. Regions (Districts) considered in northern Ghana:

- Tamale
- Yendi
- Salaga
- Damango

Fig1: Plot of crop yield for four districts

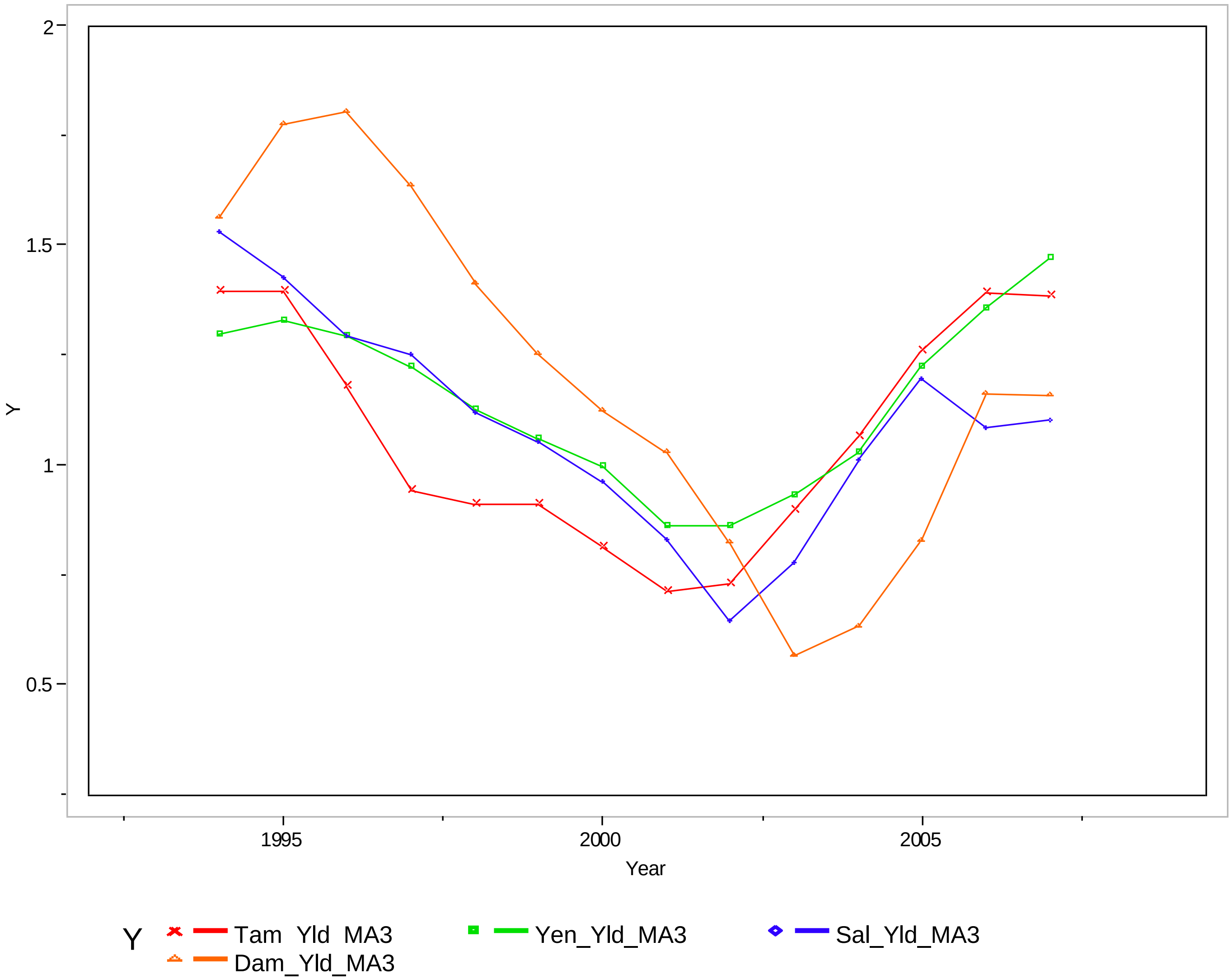
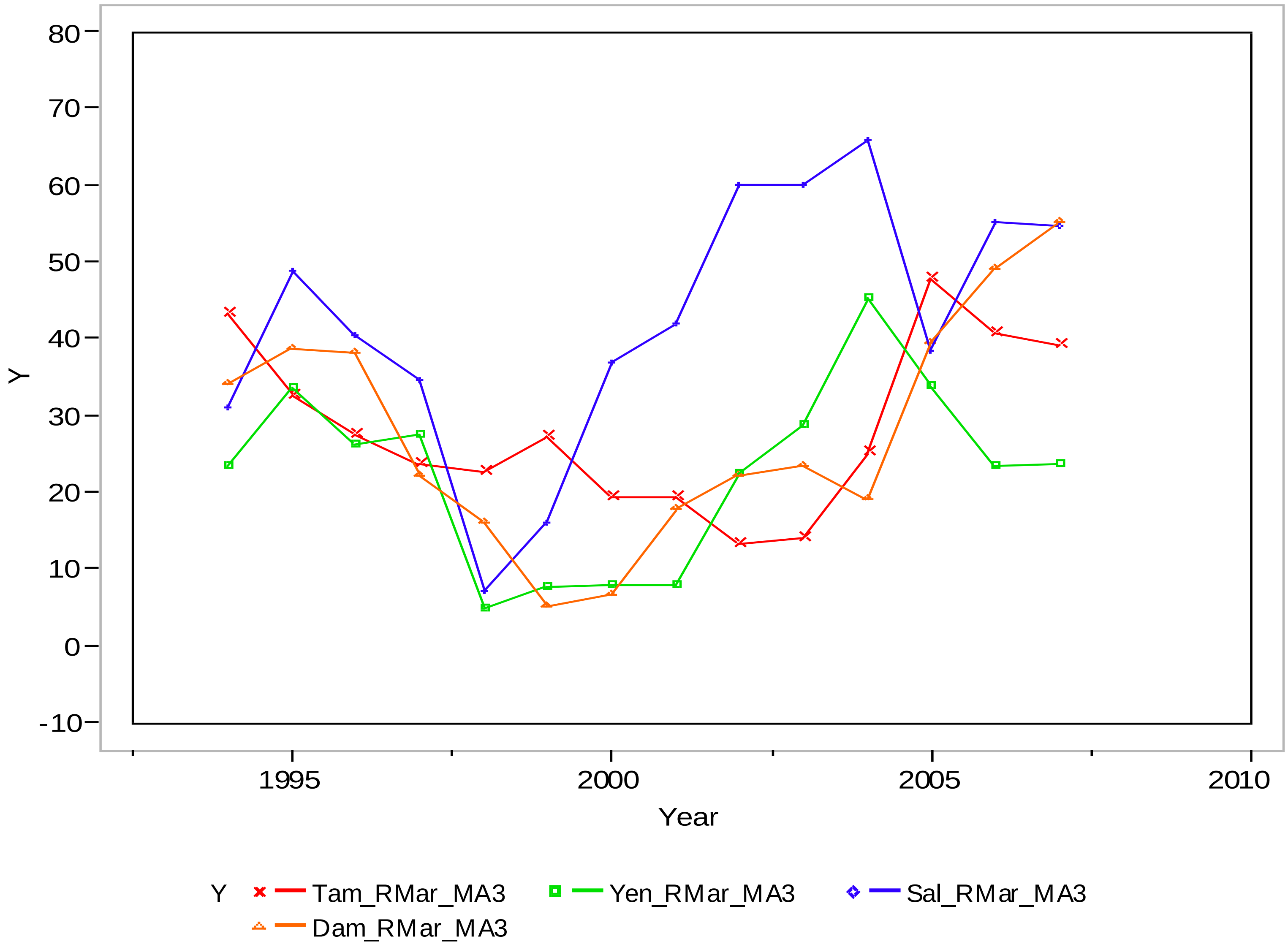


Fig2: Plot of rainfall for four districts



Crop yield, rainfall, climate factor

- We investigated further to see if broader climatic factor such as, Sea Surface Temperature (SST) also shows similar pattern

Crop yield, rainfall, climate factor

- One of the major weather factor that have impact on crop yield is rainfall
- Rainfall pattern is typically associated with global atmospheric and sea surface temperature (SST) change

Climate Change

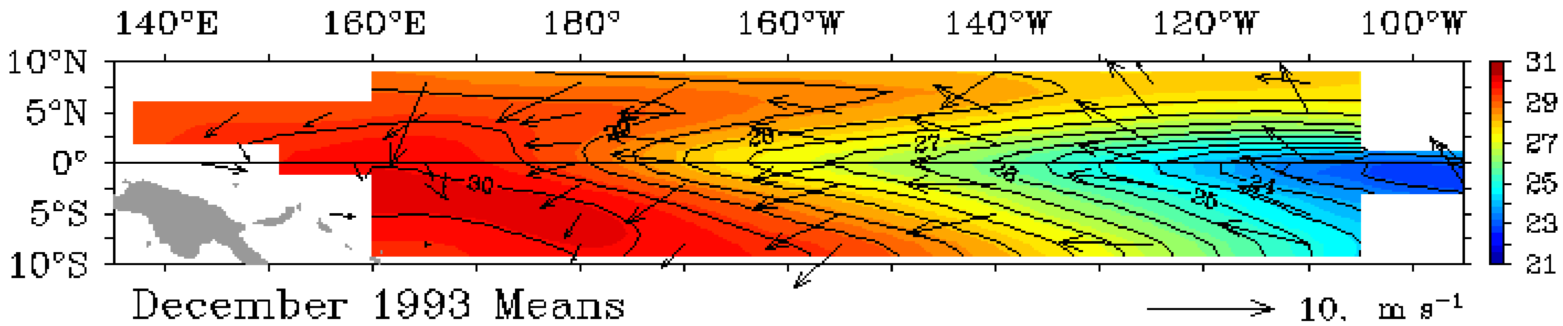
- One of the environmental anomalies that influence SST variations is El Niño
- El Niño is a naturally occurring phenomenon that influences SST and the wind pattern

Climate Change

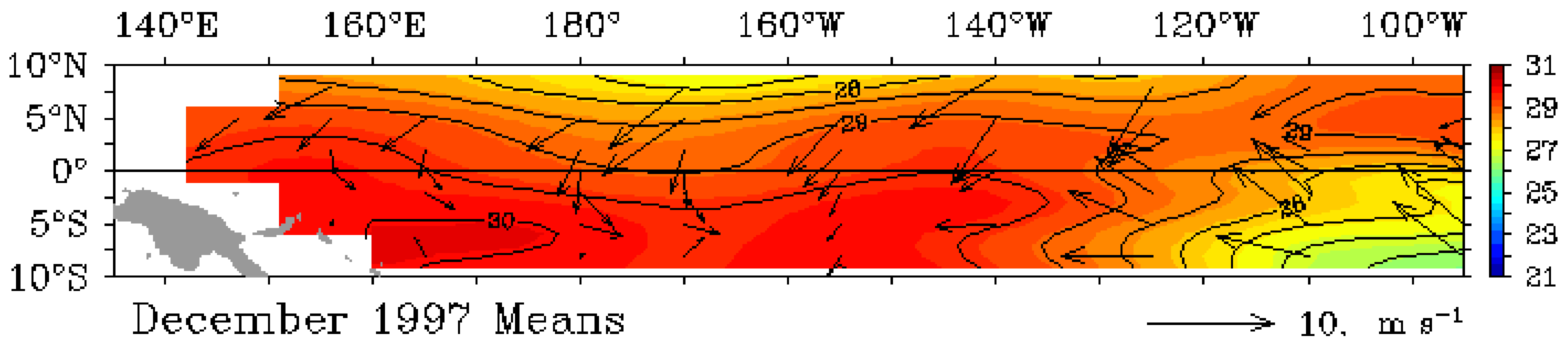
- El Niño episodes varies in their intensities and are labeled as normal/moderate or extreme/super
- During normal El Niño episode, the usual average rise of SST of the tropical Pacific Ocean is 0.5 °C
- During an extreme El Niño episode, the average rise of SST is 0.9 °C

Climate Change

Monthly Mean SST During a Normal Year



Monthly Mean SST During an El Niño Year



Climate Change

Extreme El Niño of 1997 severely disrupted global weather patterns and increased occurrence of tropical cyclones, drought, floods

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Climate Change

- The 1997 El Niño episodes extended to all continents caused US$40-$45 billion in damages and claimed 23,000 human lives worldwide
- With the global trend of increasing atmospheric and sea surface temperature, chance of a occurrence of super/extreme El Niño episode doubles to 1 in every 10 years
- Will lead to more socio-economic problems and mandate policy changes

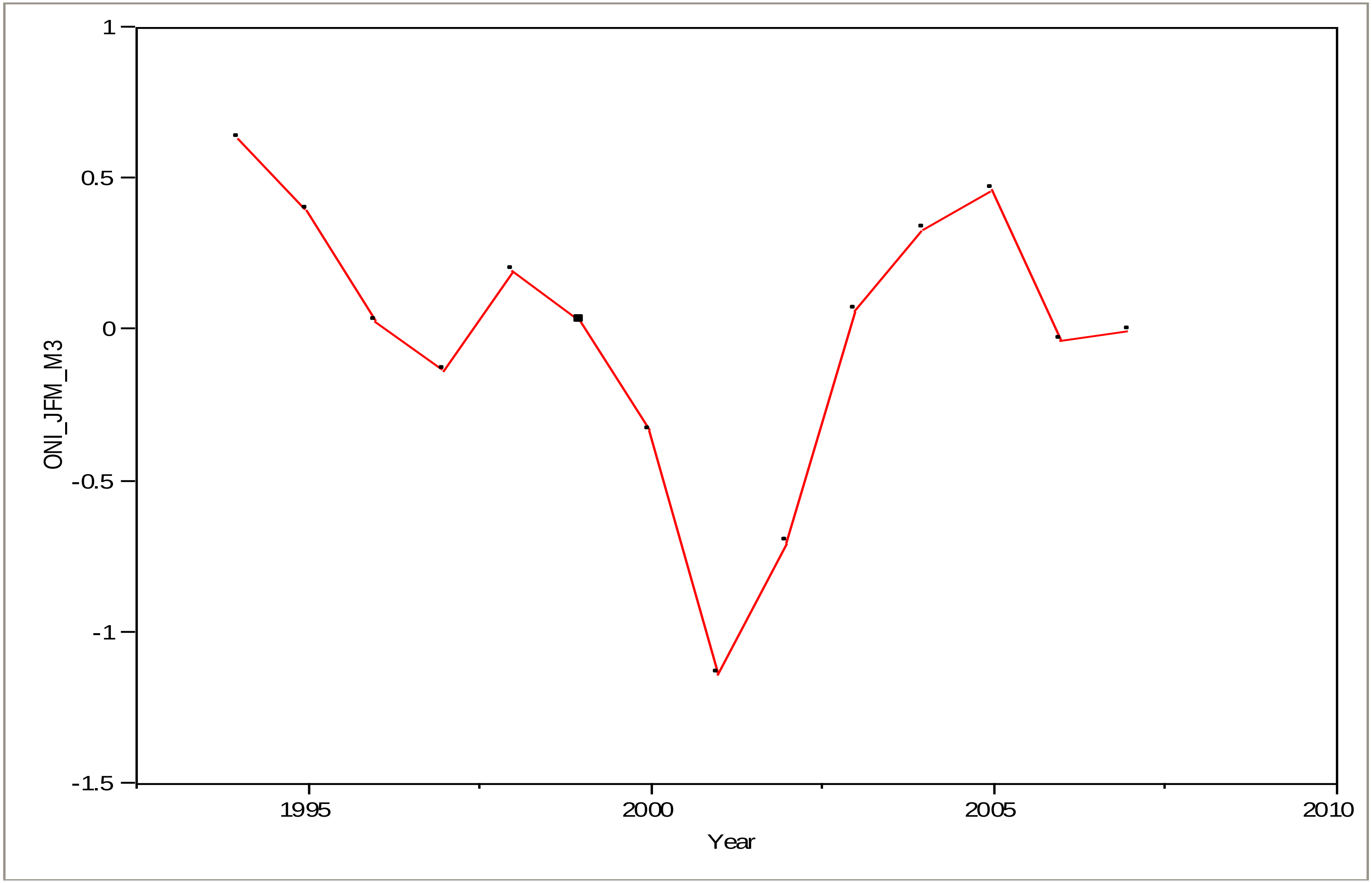
Climate Change

- How is this relevant to our research?

Climate Change

- The Oceanic Niño Index (ONI) is one of the primary indices used to monitor El Niño episodes
- ONI is calculated by averaging sea surface temperature anomalies in an area of the equatorial Pacific Ocean

Fig 3: Plot of Oceanic Nino Index (ONI)



Associative model

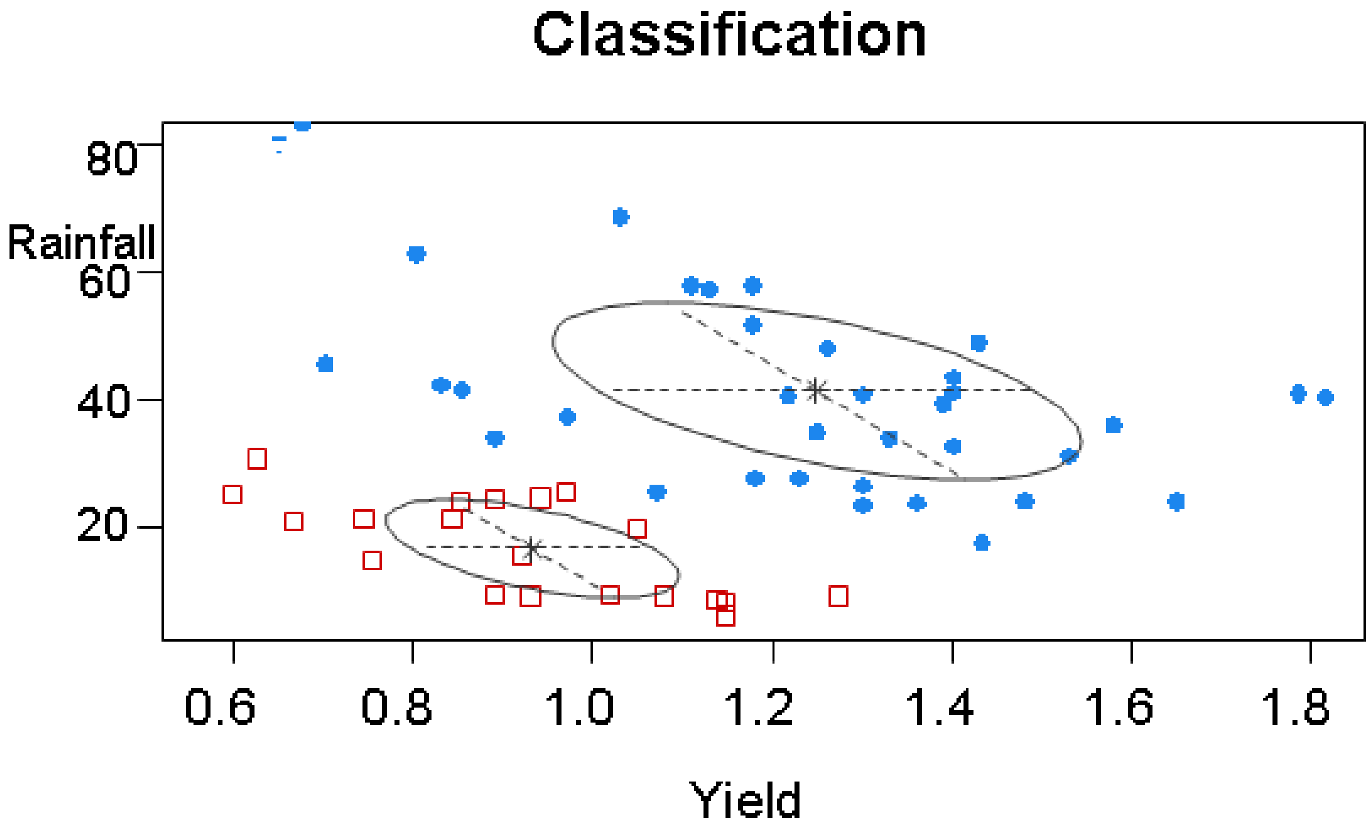
- **We develop associative model for index that incorporates linear and non-linear factors, including climate cycle.**

Associative models results of yield on rainfall for four districts

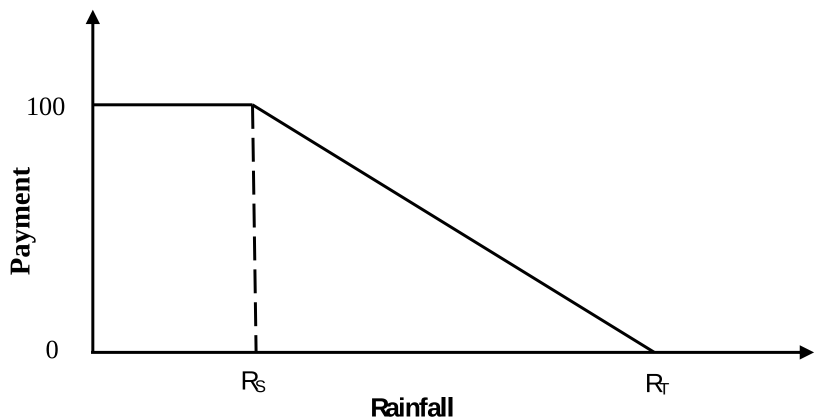
Dependent Variable (yield)	Intercept	Climate change cycle (dummy)	Rainfall	Rainfall Square	Model R-square	Corrected for Auto-Correlation
Tamale	0.2812	0.1512	0.0423	-0.0005	**86. 50%**	AR(1) [significant at 2%]
Yendi	1.0586	0.0600	0.0049	-0.00009	**97.61%**	AR(2) [significant at 1%]
Salaga	1.0829	0.0173	0.0057	-0.0001	**86.56%**	AR(2) [signf. at 1% & 5%]
Damango	1.0706	-0.7934	0.0171]	-0.00001	**88.23%**	AR(none)

Cluster Analysis for Classification

(Fraley & Raftery, 2007)



Insurance Payment Structure



R_A : Actual rainfall

R_T : Trigger rainfall

R_S : Stop-loss rainfall

CONCLUSIONS:

1. We find that cluster analysis is useful for an objective trigger identification for pay-out

2. Proper modeling of association incorporating climate cycle can provide feasible index insurance

Thank You!